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Title: Estimation of wolf population density using spatial capture-recapture: refining methods for monitoring cryptic species

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Abstract:

Wolves (*Canis lupus*) in Southeast Alaska have been proposed for listing under the U.S. Endangered Species Act first in 1993, and more recently in 2011. Reports of declining wolf populations sparked concern, in addition to high rates of logging and broad-scale succession patterns predicted to negatively impact Sitka black-tailed deer (*Odocoileus hemionus sitkensis*), the primary ungulate prey species of wolves in Southeast Alaska. Given the recurring interest of wolf viability in the region, and in order to manage wolves and their prey sustainably, it is imperative to obtain regular and reliable population estimates. However, monitoring wolves in temperate rainforests is challenging because the landscape obscures visibility and lowers success of traditional methods such as aerial surveys and radio collar mark-recapture. We used hair snares to collect DNA samples and spatially-explicit capture-recapture (SECR) models to estimate fall wolf density during 2012–2015 on northcentral Prince of Wales Island (POW), Alaska. We incorporated covariates including sex, behavioral responses, and site-specific changes in effectiveness of detection probability by fitting hybrid mixture models to the data. We also incorporated into our models landscape variables including forest habitats in various management conditions and succession stages to relate to wolf habitat selection. We concurrently implemented a traditional approach for comparison to the DNA-based SECR method using radiocollared wolf data to estimate population abundance with minimum counts and the size of wolf packs and pack territories. The results of the DNA-based SECR method proved to be more reliable, efficient, cost-effective, and robust than the traditional method, which was sensitive to violations of model assumptions. Our efforts to improve SECR density estimate precision by increasing the hair sampling intensity and area resulted in more wolf hair detections and redetections, and increased the number of unique wolves redetected. Based on multiple lines of evidence, we report a decline in wolf population abundance over the past 2 decades in northcentral POW. We conclude that DNA-based SECR is an effective tool for regular population monitoring, as is required in situations of elevated concern for the persistence of a population, and may simultaneously provide information on heterogeneous landscape use, an important wildlife management consideration in fragmented forests.